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ABSTRACT

A plan for studying management procedures that structure the relationships between federal agencies and federally-created research and development (R&D) organizations is discussed. The objective is to identify the types of federal management approaches, examine these approaches from the perspective of their relative emphasis on accountability and autonomy, and determine if there is an association between types of approaches, agency and center characteristics, and center performance. Center activities to be examined, in terms of the impact that management procedures have on conducting the activity, include: specifying the center's purpose; defining the center's portfolio of projects and planning individual R&D tasks; managing ongoing center operations (e.g., staffing); conducting the substantive R&D program of the center; disseminating results and/or providing technical assistance; and evaluating the center's performance (criteria and procedures). An autonomy scale will be used to rate federal control over each major center activity, and a summary index of control will be developed to describe the degree of autonomy given to each center by its sponsoring agency. In addition, system descriptors will be analyzed for their association with autonomy and their influence on center performance. Approaches to measure center accomplishment are also discussed. (SW)

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MANAGEMENT OF FEDERAL R&D CENTERS

1. INTRODUCTION

Through legislative direction or administrative decision, federal agencies often establish new organizations (usually called centers) outside the federal system to carry on research, or research related activities. These organizations are given some degree of independence with respect to the programming of their funds. Prior government authorization of individual projects may not be required. However, the purpose of the work, the substantive area, and the types of tasks to be performed are subject to varying degrees of specification.

The decision to establish such an organization does not necessarily dictate the relationship between the federal agency and the external R&D center. The agency must still choose a management process that will enable it to ensure accountability for the use of federal funds. Are the funds spent according to federal regulations and the standards set by the sponsoring agency? Are they spent for the agreed upon purposes? At the same time, the management process must permit the R&D organization the autonomy and flexibility required in order to achieve its purposes. The management process must also include techniques for assessing the accomplishments of the R&D Center.

This paper presents a plan for studying the range of management procedures used to structure the relationships between federal agencies and the R&D organizations that they create. The purpose of this research is to identify the types of federal management approaches, examine these approaches from the perspective of their relative emphasis on accountability and autonomy, and determine if there is an association between types of approaches, agency and center characteristics, and center performance.

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2. BACKGROUND AND ISSUES

Many of the programs of the federal government are carried on by agencies and people outside the federal system.[1] They may be operated from, for example, state offices, universities, profit-making organizations, or community corporations. Federal money is transferred to these organizations through a variety of arrangements. These transactions raise an important issue: how can this funding process and the ensuing relationships be managed so that federal funds are spent in legitimate ways for the intended purposes? Ensuring accountability implies placing constraints on the actions of the funded organizations. On the other hand, the procedures designed to achieve accountability must not discourage agencies from applying for funds—if this happens, national goals cannot be achieved; nor should the procedures limit the organizational autonomy required to carry out the program.

Achieving a balance between accountability and autonomy is a pertinent issue for federal managers responsible for funding research and development activities. A recent report of the Office of Technology Assessment discusses this problem. It points out that the importance of science and technology to agency missions, and the inherent uncertainty of R&D outcomes, has led the federal government to abandon traditional procurement procedures in favor of subjective selection procedures for R&D transactions.[2] These procedures are based on the perceived scientific and technical merits of a potential performer's capabilities and approach to a problem. However, this departure created a new set of problems.

> Such an approach places a responsibility upon executive agencies to develop the necessary expertise to select among the many technological alternatives that present themselves and to ensure that the work funded meets government needs at a favorable price. Despite the need for the executive agency to exercise effective control, sufficient latitude must be given the performer if creative work that meets mission objectives is to be attained. Thus, a delicate balance requiring a high degree of judgment must be struck in the relationships between the executive agencies and performing institutions in the procurement of R&D.[3]

Research performers have recently expressed concern that federal management practices are not achieving this "delicate balance." In 1979, six educational groups established a National Commission on Research to review the range of problems associated with federal funding of academic research. Cornelius Pings (California Insitute of Technology), director of the Commission, expressed the group's concern that the mechanisms of funding are beginning to interfere with the research itself. He said: "many observers charge that the burdens of seeking and administering federal funds have become so cumbersome, costly, and complex as to weaken the research effort and the institutions where that research takes place."[4] The topics that the Commission will consider reflect its perception of the problem areas: criteria for funding, recovery of direct and indirect costs, duration of grant periods, agency involvement with project substance, and accountability for the expenditure of funds. All these problems are affected by the way the management process balances accountability and autonomy.

The Office of Management and Budget (OMB) was required by the Federal Grant and Cooperative Agreement Act (PL 95-224) to conduct a study of federal assistance programs and practices. The final study plan, published in January 1979, specifically included R&D activities in the scope of the study. Responses to a tentative plan, released earlier, had stressed the importance of finding the appropriate relationships and the most effective level of federal involvement required to attain research objectives. The final study plan cited several issues relevant to finding the appropriate balance including:

- the effect of using different funding mechanisms--the consequences for the different funding agencies and the performers
- the issues related to varying degrees of federal direction and control over research and development
- the issues that arise from research arrangements with different types of recipients.[5]

R&D centers established by federal agencies outside the federal system are good subjects for research on the effects of management procedures in general, and the issue of balancing autonomy and accountability specifically. This is because they operate under funding arrangements that permit them some range of autonomy which varies from center to center.

Centers also appear, based on preliminary discussions with managers of federal programs that support such efforts, to differ with respect to the purpose(s) for which they are established. Thus, for example, centers may be created to:

- develop a coherent approach towards a particular problem (e.g. by establishing a locus for interdisciplinary work, ensuring a "critical mass" of researchers working together in a given area, or stimulating research in an area that is perceived to need greater emphasis)
- attract researchers of particularly high caliber
- obtain independent, informed advice regarding agency policy (e.g. by assisting in the definition of agency research objectives or program plans)
- provide "leverage" by attracting funds from sources other than the agency establishing the center
- ensure the stability required for long term research efforts, and/or
- locate researchers in close proximity to potential users of research results (in applied fields) in order to involve the users in the research, encourage the transfer and utilization of results, and/or to provide a source of technical assistance.

Information about the extent to which extramural centers do, or can, achieve any one of these goals is lacking. Support for using a center mechanism may rest in agency files, but it is otherwise unavailable. Accessible material on multi-project programs addresses issues related to in-house federal laboratories.[6] In addition, there is a lack of information about the management of these centers. How management procedures vary in relation to the purpose of a center, and how these procedures affect performance are open questions.

Our lack of empirical knowledge is illustrated by comments made by two sub-groups of the task force on research and development of the OMB study referred to above. Both sub-groups were addressing the concept of a "master agreement"—a funding arrangement similar to agreements that may be used for establishing centers. An agency using a master agreement enters into an arrangement with a performer that constrains only those terms and conditions perceived to be essential, leaving many activities unspecified. Task orders for individual statements of work can then be issued as needed. According to one sub-group, the benefits of this arrangement are:

a. Reduction in the time and effort required to initiate research.

b. Simplification of the award process and administration for the agency through standardization, and by having only one basic arrangement with an institution rather than multiple arrangements.

c. Reduction in administrative burdens on the performer.[7]

A different sub-group of the research and development task force pointed to disadvantages of the master agreement. Their argument is that the master award, or block grant, violates the standards of open competition and selection on the basis of competence.

> Some federal agencies have established procedures for the amendment of basic research contracts permitting the initiation of new research ventures upon completion of the most cursory approval procedures. The fact that these research projects are not subject to pre-award selection processes that apply to most researchers, is fundamentally inequitable and compromises the goal of competitive support for research of the highest quality.[8]

In addition, they contend that the master award develops relationships which can result in placing research money in the hands of a small number of institutions, limiting the distribution of funds within the research community. They see block grants as justified only in cases where there has been a heavy commitment to specialized research equipment.

Such a division of opinion can exist because the information about the effects of management procedures used by the agencies to structure their relations with extramural organizations is limited. Funding methods, according to the OMB task force on research and development, are chosen by Congress and the Executive Branch without a thorough exploration of all the available means of implementing federal responsibilities when drafting legislation.[9] Executive agencies appear to be influenced by unique historical patterns and previous policy.[10] Conventional wisdom, often expertly applied, is presently the major basis for making these decisions.

3. RESEARCH DESIGN

The subjects of this study are federally-initiated R&D centers funded through some type of block or master award. The scope and objectives of the study are described in Section 3.1. The analysis focuses on the relationships between three sets of variables: center and funding agency attributes, management procedures, and center performance. The relationships between these variables and their operational definitions are described in Section 3.2. Because information about these centers is sparse, the research design presented here is subject to refinement and expansion. Data must be collected for the purpose of clarifying the conceptual framework and operationalizing the variables prior to collecting data about agency-center relationships. This will be accomplished through consultation with a federal advisory committee. These procedures are discussed in Section 3.3.

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The data will be analyzed in terms of the types of management procedures and center functions. Therefore, the results of the study will not be reported in a way that will identify specific agencies and centers.

3.1 Scope and Objectives

The objective of the study is to assess the association between the performance of R&D centers in accomplishing their various purposes and control over the centers, as it is reflected in federal management procedures. This objective will be accomplished through carrying out the following procedures:

- identify the R&D organizations established by federal agencies
- describe the variety of management procedures used by federal agencies
- analyze the type and degree of control over specified center activities represented by various management procedures
- identify criteria for measuring center performance and apply these criteria to centers
- analyze the association between the management procedures used and the characteristics of centers and agencies
- analyze the association between the degree of control and performance
- analyze the extent to which other characteristics of the agency and center affect the association between control and performance.

This study focuses on a specific type of R&D performer: federally-created R&D centers outside the federal system. It is not intended, however, to exclude centers that are affiliated with other institutions. Units within other organizations, such as universities, are included in this study. Nor is it intended to exclude centers that had originally, or at a later time, received funds from sources other than the federal sponsor. Indeed, many centers are established with the expectation, or even the requirement, that they find support from other sources. The important element is that a center was created as a result of federal action.

A second selection criterion is based on the type of funding mechanism used to create these centers. It can only be described in a general way because the terminology applied to funding mechanisms and actual procedures varies across agencies. The relevant type of funding can be described as a master award, or alternatively, block funding. By this we mean, that centers are funded on the basis of a general agreement, usually to achieve specific purposes, but with the content of the program not precisely specified. This method contrasts to funding on a project-by-project basis. An empirical definition based on agency operations will be developed from the data collected through this research.

We do not plan to place any limitations on the type of substantive programs undertaken by the centers. They may be broad or narrow in scope and address various subjects. This variety can be easily illustrated. The EPA has recently established three research centrs to study different aspects of pollution. NIMH funds the White Cloud Center for American Indian and Alaskan Native Mental Health Research and Development. The National Center for Appropriate Technology, established by the Community Services Administration, addresses itself to developing and expanding appropriate technology solutions to energy and energy-related problems experienced by low-income communities.

It is important, for the purpose of this research, to collect data that reflects the diversity of characteristics of centers and sponsoring agencies. No limits, therefore, will be placed on the type of funding agency or center for inclusion in the study. Broad representation from multiple executive departments is desired in order to identify and analyze the variation in management procedures as well as the range of functions, substantive programs, and R&D tasks among the centers.

The management procedures relevant to this study have three possible purposes: they may be directed toward ensuring compliance with program requirements, administrative requirements, or general federal policy requirements. Program requirements are the terms or conditions of an assistance instrument that are designed to ensure that the substantive purposes of a program are achieved. Administrative requirements deal with business processes such as determining costs, financial reporting, and public reporting plans. General federal policy requirements are intended to implement national statutory goals that are usually unrelated to the substantive purpose (e.g. use of minority contractors).

Center activities to be examined, in terms of the impact that management procedures have on conducting the activity, include:

- specifying the center's purpose(s)
- defining the center's portfolio of projects and planning individual R&D tasks
- managing on-going center operations (e.g. staffing, procuring equipment or facilities)
- conducting the substantive R&D program of the center
- disseminating results and/or providing technical assistance
- evaluating the center's performance (criteria and procedures)

3.2 Conceptual Approach

The conceptual approach rests on the assumption (reflecting statements presented earlier in this paper) that federal control over an R&D program can reach a point at which scientific performance is hampered; or, alternatively, that a certain degree of autonomy is required for scientific productivity. This point, or degree, is undefined and the relationship between the amount of autonomy required for performance and the amount of control required for accountability is usually referred to imprecisely (e.g. as "a delicate balance"). However, control, or autonomy, can be more precisely defined through examination of management procedures.

For purposes of analyzing the degree of control, the management process will be divided into two stages and the procedures used in each examined separately. The first stage is the period during which the centers are selected from a number of applicants. The second stage is the period of center operations. It will be possible to develop a summary measure of federal control for each stage as well as a measure of control over the individual activities conducted during each stage.

During the selection period the analysis will address the extent to which the solicitation issued by the agency specifies the various aspects of the center's program. To what extent is the substantive area limited? How much freedom does the center have to define projects? How much scope does it have in its administrative activities? The definition of operational indicators of control during this period requires further development.

During the operating period, autonomy will be defined by the extent to which the federal program officer controls decisions about center activities. This will be measured on a scale comprised of five items identifying different degrees of control. The program officer either:

- has complete responsibility for the decision
- provides general supervision (refers to continuous involvement in the activity and more or less shared decision making)

- must be consulted (refers to involvement only at specific times and more or less shared decision making),
- must be notified but has no responsibility for decision, or
- has no responsibility.

The autonomy scale will be used to rate federal control over each major center activity. These activities may include:

- research program planning
- selection of projects carried on by center staff
- proposal preparation by center staff
- selection of grants awarded by the center (for those centers that fund research themselves)
- selection of subcontractors
- selection of center personnel
- financial management of the center
- acceptance of funds from sources other than the sponsor agency.

The above list includes both program and administrative activities. The usefulness of separating these two types of activities will be considered as will the expansion of the number of items on this list.

A summary index of control will be developed to describe the degree of autonomy given to each center by its sponsoring agency. The collection of information about the amount of autonomy a center has with respect to its major activities provides the data for comparing the centers, and for analyzing the association between autonomy and performance.

Other indicators of federal control during the operational period will be examined. These indicators are: the number of reports required, the content of the reports, and the number of site visits. It will also be necessary to identify the criteria used for monitoring ongoing activities.

Several system descriptors will be analyzed for their associations with autonomy as well as their influence on center performance. These system descriptors include:

- center function or purpose
- type and number of R&D tasks
- original agency sponsor
- industrial focus
- technological focus
- stability of the center
- resources
- substantive program focus

They are operationally defined below.

The center function is usually identified in a general statement about the purpose for which it was established. For example, the National Institute of General Medical Sciences gives research grants:

> to encourage research collaboration between basic and clinical scientists on a group of closely interrelated projects which are focused on solving a clearly identified biomedical research problem within a field specified by the Institute.[11]

An illustration of a more specific statement of purpose comes from the rules and regulations issued by the Public Health Service to describe the requirements for centers funded by the National Center for Health Services Research.[12] These centers are to carry out multidisciplinary health services research respecting:

- he accessibility, acceptability, planning, organization, distribution, technology, utilization, quality, and financing of health services and systems
- he supply and distribution, education and training, quality, utilization, organization, and cost of health manpower; and
- he design, construction, utilization, and cost of facilities and equipment

These kinds of statements will be scrutinized to produce a comprehensive list of functions assigned to the centers.

A second system descriptor is the type(s) of R&D task(s) carried on by the centers. These tasks are defined below:

- Basic Research—Work of a general nature intended to apply to a broad range of applications or to the development of new knowledge about an area.
- Applied Research—Work involving basic knowledge for the solution of a particular problem. The creation and evaluation of new concepts of components but not development for operational use.
- Development—The combination of existing or feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. The application of known facts and theory to solve a particular problem through exploratory study, design and testing of new components or systems.
- Technical Service—Cost/performance improvement to existing products, processes or systems. Recombination, modification and testing of systems using existing knowledge. Opening new markets for existing products.
- Information Transfer—Planned programs to communicate information about the center's substantive area to either the sponsoring agency or others. This includes providing technical information: collecting, reviewing, processing and distributing information; training programs; and/or technical assistance.

The subject matter, or substantive focus of the program, must be taken into account. This descriptor will vary considerably across centers. In discussing the scope of the study above, examples were given to illustrate this variance.

Two other variables are included as system descriptors because they could affect both performance and the criteria for evaluating

performance. These variables are the industrial focus and technological focus of the centers' programs. Both can be described as either specific or diffuse. An example of a specific industrial focus is the NOAA fisheries program. The DOE solar technology program illustrates a specific technology focus.

Resources is a descriptor comprised of five variables. The first is the amount of the center's budget. Second, the amount of federal funding from all sources. Third, the percentage of the budget covered by federal funding. Fourth, the percentage of the budget covered by funds from the original federal sponsor. Fifth, the number of funding sources. This information will be collected for the year of origin and following yearly intervals.

Stability of the center will be measured in three ways: the length of time the center has been in operation, the period covered by the original grant, and by changes in amount of the budget indicators, listed above under resources, over the operating period.

Finally, the study will include the sponsoring agency as a system descriptor. The information will be used only to categorize centers; no attempt will be made to discuss the factors that lead agencies to select specific management procedures. The procedures provide the basis for the data used to estimate autonomy.

Center performance represents the dependent variable in this study. It can be looked at from two points of view: The accomplishments of the center, or the factors that hamper performance. Data can be collected to represent both perspectives. This data may be either combined into a single measure of performance or used separately.

Accomplishment, as the indicator of performance, presents both definitional and measurement problems. The definition of accomplishment may vary from center to center since it is contingent upon the center functions and expectations of the sponsoring agency. For example, some centers are established to attract money, for work in a specific area, from organizations other than the sponsoring agency. Other centers are expected to aid the sponsor in different ways, or to work with user communities outside the federal government. The goals set for a center must be clearly defined and accomplishent defined within the context of those goals.

Two approaches can be taken to measure accomplishment. It is possible to use the subjective perceptions of the federal sponsors and center staff as a basis for assessing performance. Accomplishment can also be measured quantitively using center products and other results as the data.

A center's accomplishment can be assessed, with respect to the center's function and goals, by subjective data. Rating scales can be developed to obtain assessments from center directors, the federal project officer who is immediately responsible for a center, and from policy-level officials in the federal agency who are knowledgeable about the center. The study will also identify the criteria and indicators used for making the assessments as an aid to interpreting the performance ratings. Data will also be collected about criteria used for periodic monitoring purposes.

Accomplishment can also be measured through quantitative data based on center products and results. If, for example, a center is intended to attract money from sources other than the primary federal sponsor, a measure of accomplishment could be the number of sources of center funds, or the fraction of the budget derived from

sources other than the primary sponsor. Other indicators could be the production of written reports, attendance of center staff at professional meetings,[13] or the number of articles published in prestigious journals.[14] Interpretation of these indicators is contingent upon the function of the center, the context of the disciplinary field, and the R&D tasks undertaken by the center.

A second approach to examining performance is to identify the point at which R&D activities, or productivity, are impeded by federal management procedures. This data would be based on the perceptions of both center management and agency management. They could be asked to specify the impact of control on each center activity previously described in connection with the measurement of autonomy.

To sum up, the conceptual framework is comprised of three sets of variables: autonomy, performance, and system descriptors. The latter set is a number of variables selected for inclusion because they describe the organizational system. Table 1 lists the three variable sets and their data indicators.

The analysis rests on the assumption that the degree of autonomy given a center by its sponsor will be associated with center performance. Attributes of the organizations, the system descriptors, are included in order to examine their potential association with both autonomy and performance, and their potential effect on the relationship between autonomy and performance. It should be acknowledged that there are variables that have been found to be associated with scientific productivity (e.g. work setting and individual characteristics) that are not included in this framework.[15] The assumption is made that these characteristics will be randomly distributed among the centers and so will not affect the relationships found in this

TABLE 1

CONCEPTUAL FRAMEWORK

VARIABLES	INDICATORS
Autonomy	A scale rating federal control over these activities: 1. program planning 2. internal project selection 3. internal proposal preparation 4. selection of grantees 5. selection of subcontractors 6. selection of personnel 7. financial management 8. acceptance of funds from other sources
Performance	
a. Accomplishment	a. • perception and criteria of federal manager • perception and criteria of center managers • productivity: publications and meetings • other measures contingent on function
b. Barrier	b. perceptions of federal and center managers of federal control on each center activity listed above
System Descriptors	
a. Function	a. specific or diffuse
b. R&D tasks	b. type and number
c. Technology focus	c. specific or diffuse
d. Industry focus	
e. Substantive area	
f. Agency sponsor	
g. Resources	g. • total budget • total federal funds • percent of federal funds in budget • percent of sponsor's funds in budget • number of funding sources
h. Stability	h. • time in operation • period covered by original grant • change in budget over operating period

study. This assumption, however, will be subject to examination during the analysis.

The approach described in this section may be revised or expanded. The final plan will be developed after consultation with federal agency managers during the first phase of data collection.

3.3 Data Collection

The data collection will proceed in three stages. The first involves consultation with an advisory committee comprised of agency policy officials who will help to clarify the issues and identify information sources. Secondly, interviews will be conducted with a small sample of R&D agency managers and heads of centers as an aid to selecting and operationalizing the research variables and designing the basic data collection forms. Finally, survey forms will be developed and sent to the heads of R&D centers and the managers of federal programs funding these centers.

Federal agency policy officials will be invited to serve on an advisory committee that will participate in various aspects of this study. Initially, committee members will identify what they see as the major issues and important decisions they must make relevant to establishing and monitoring R&D centers. This information will be incorporated into the framework for the study. The committee will provide information about relevant agency policies and descriptions of sponsored R&D centers. They will later be asked to review and comment on drafts of the interview guidelines and survey forms. The committee will be requested to review and comment on the research report prior to publication.

In-de th interviews will be conducted with a small number of managers o federal programs that support R&D centers and of center directors. The interviewees will be selected to represent a variation in each of the following characteristics: center mission, substantive focus, disciplinary area, R&D tasks, and sponsoring agency. The information gained from these interviews will be used to identify and operationalize the research variables, and will be used in designing the survey forms.

Following the developmental work described above, and the compiling of a list of R&D centers within the scope of the study, survey forms will be designed. The survey population will include the directors of all R&D centers and the heads of sponsoring agencies. The form sent to center directors will collect information about center characteristics, operations, funding sources, contacts with the sponsoring agency, and center output. Federal managers will be asked about management procedures, and criteria and methods used to evaluate center accomplishments.

4. SIGNIFICANCE

The study has been designed to provide managers of federal R&D programs, and policy level officials with responsibility for center programs, with information that help them in selecting appropriate processes for managing centers that have various goals. Additionally, the study will document the variety of approaches now used for managing R&D centers--with emphasis on defining the criteria and methods used for evaluating center performance.

The first stage of data collection is intended to sharpen the study's focus on management issues that are of concern to federal agencies. Policy level officials, serving as a project advisory committee, will be asked to identify those issues, within the overall context of the study, that could be affected by policy or management initiatives and

to help specify the kinds of da ' that are needed to inform their decisions. This procedure is i ended to ensure that the results of the study are relevant to the needs of federal policy makers and managers.

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